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(54) **Heating or cooling device**

(57) A heating or cooling device to be applied to a body for medical or veterinary use comprises a container having enclosed therein a heating or cooling composition comprising a material which is exothermically or endothermically soluble in water, water and thickener. The material which is exothermically or endothermically soluble in water is contained within the container in crystalline form, the crystals being of varying size so that the speed and length of their reacting times with water can be more readily controlled. The device may also contain a heat sink such as sand. The device is preferably compartmentalised to enable it to be more readily placed around, for example, an animal's leg.

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DESCRIPTION

HEATING OR COOLING DEVICE

The present invention relates to a heating or cooling device which is suitable for veterinary or medical purposes.

GB-A- 2011057 discloses a heating or cooling device which heats up or cools down to a more medically acceptable temperature and which remains at an elevated or lowered temperature for a longer period of time than previously known devices.

This is achieved using a device comprising a container, said container being of a laminated material having an inner flexible polyethylene layer and an outer nylon reinforcement and said container having enclosed therein a heating or cooling composition comprising a material which is exothermically or endothermically soluble in water, water and thickener, and said heating or cooling device having means separating the exothermic or endothermic material from the water.

However, the device described therein suffers from a variety of problems. These problems include:

1. An inability to control accurately the operating temperature range;

2. An inability to control the device such that the device will remain at an elevated or lowered temperature

range for a reasonable working period;

3. A failure to provide an effective device for use on surfaces which require the device to be positioned in a non-horizontal position;

4. An inflexibility which prevents the device being moulded about the article or body it is to be fitted to; and

5. A proneness to leak due to the "thinners" of the contents contained therein.

It is an object of the present invention to overcome these problems and the objectives are as follows:

1) To control more accurately the operating temperature range within an acceptable maximum and minimum temperature, particularly for medical and veterinary uses.

2) To extend the period of time that the device will remain at an elevated or lowered temperature within the acceptable maximum and minimum temperature ranges described in 1) above.

3) To prevent the contents of the device from flowing to the bottom due to gravity (causing only the bottom of the device to give out or absorb heat and leaving the top of the device containing only gas) when applied to any non-horizontal surface and particularly when applied to a nearly vertical surface for medical or

veterinary use, and especially when applied to a horse's leg or other nearly vertical part of a human or animal to enable the beneficial heating or cooling effect to be distributed evenly from the bottom to the top of the device.

4) To provide a device which can be moulded to suit the shape of the part to which it is applied thereby ensuring uniform heat emission, or heat absorption from the whole surface to which it is applied. This is particularly important when the device is to be applied to joints and other irregular shapes on a human or animal's body, and

5) To provide a device which will not leak contents and contaminate anything in contact therewith.

According to the present invention there is provided a heating or cooling device which comprises a container having enclosed therein a heating or cooling composition comprising a material which is exothermically or endothermically soluble in water, water and thickener, and said heating or cooling device having means separating the exothermic or endothermic material from the water, characterised in that said material which is exothermically or endothermically soluble in water comprises particles of various size.

Preferably the range of said particle sizes is such that the overall initial exothermic or endothermic reaction is reduced by the inclusion of larger particle sized materials, which larger particle sizes take longer to dissolve, thereby slowing the reaction down and increasing the length of reaction time.

This differs from the art which uses ingredients in powder form (very small particle size). Such devices suffer from the disadvantage that, when the materials are dissolved in water, they dissolve very quickly. The resulting exothermic or endothermic reaction is quick so that very high or very low initial temperatures are produced and, when the reaction has finished, the device soon returns from these very high or very low temperatures to ambient temperature since all chemicals have dissolved and none remain to continue the reaction.

By using exothermic or endothermic chemicals of selected particle size the rate of initial exothermic or endothermic reaction can be varied. By using larger particle sizes, the rate is reduced and, since larger particles take longer to dissolve the reaction is slowed down and continues for longer duration i.e. it continues until the largest particles have all dissolved.

Thus, by carefully selecting the particle size of the reactants acceptable temperatures can be reached initially, which temperatures can then be maintained

within an acceptable temperature range for an extended period of time.

In the case of the endothermic device the particle size of the endothermic material is preferably between 1 to 3 mm. Larger particle sizes can be used to suit particular applications.

In the case of the exothermic device and especially when it is for medical or veterinary use,the initial temperature should not rise above 55°C if the device is to be applied directly to the skin and the temperature should preferably remain above 40°C for 30 minutes, the ideal temperature being 43°C for a period of 20 minutes.

When the exothermic device is not applied directly to the skin the initial temperature needs to be higher so that sufficient heat can penetrate through any insulating layer between the device and the skin so that a skin temperature of between 55°C and 40°C can be maintained for a period of 30 minutes.

In one application for medical and veterinary use, the insulating layer may contain medication which, when heated by the device, will draw poison and infections from the body in a similar manner to a hot kaolin poultice, medication to suit particular types of application or injury may be incorporated into the dressing.

Thus, using the device, existing types of medication can be applied to the skin hot, and remain hot within a controlled medically acceptable temperature range for much longer compared with traditional methods in which the medication is placed in hot water first and then applied to the skin at an often too-hot temperature which cools too quickly to be of lasting benefit.

The dressing may be applied to the skin first and then the exothermic device attached, or the dressing may be attached to the device first and then applied to the skin together with the device.

In the case of the exothermic device for medical and veterinary use, if the exothermic ingredient is calcium chloride the particle size will vary from 1mm to 5mm as follows:-

The ratio of material 1-2mm to 2-5mm will vary according to the maximum and minimum temperature range required and the duration of time that the temperature remains within the temperature ranges.

For medical use for contact to skin:-

The ratio of 1-2mm particle size to 2-5mm particle size is between 20:20 and 5:35 by weight.

For medical use to be insulated from the skin with medicated dressing and for veterinary use:-

The ratio of 1-2mm particle size to 2-5mm particle size is between 40:0 and 20:20 by weight.

The precise ratio of particle sizes to suit each type of exothermic device will depend on which other types of temperature control which are also being used (e.g. sand as a heat sink).

The time duration of exothermic and endothermic devices can be extended further.

According to another aspect of the present invention there is provided a heating or cooling device which comprises a container having enclosed therein a heating or cooling composition comprising a material which is exothermically or endothermically soluble in water, water and thickener, and said heating or cooling device having means separating the exothermic or endothermic material from the water, characterised in that said device further comprises a substance or substances which together or alone provide absorption of solution and heat sink properties.

The substance or substances which together or alone provide absorption of solution and heat sink properties can be any suitable solid or liquid with a high specific heat coefficient. It is preferably of a light colour so as not to impair vision of dyes to be described hereinafter. In a preferred embodiment, a silica sand or silver sand is used. The addition of such a substance achieves the objects referred to in objects 1

and 2 since it absorbs the initial 'surge' of heat from the exothermic device to prevent an otherwise unacceptably high initial temperature, and as the exothermic rection slows down the substance yields up its stored heat to prevent the device from cooling quickly, thereby providing an acceptably uniform temperature for a longer period of time.

If silica sand is the heat sink material and calcium chloride is the exothermic material then the ratio of sand to calcium chloride would be between 300:40 and 40:40 depending on the amount of heat storage required for each application within each specified different temperature range and time duration.

In the case of the endothermic device, the principle is reversed, in that heat is initially extracted from the sand by the endothermic reactions to prevent a too cold initial temperature and the sand is then available to absorb heat as the endothermic reaction slows down. This extends the period over which the device is useful or effective.

When the endothermic materials are urea and/or ammonium nitrate and the heat sink material is sand, the ratio of sand to endothermic material would be between 50:50 and 50:200 by weight.

The inclusion of sand also achieves the object referred to as object 4 and, when used together with

thickener or with increased quantities of thickener, this enables the device, when the outer covering is flexible, to be moulded to suit the shape of an object to be moulded, for example, to fit the shape of the body part to which it is applied.

The same sand and thickener principle applies to achieve the object referred to as 5 by preventing the contents of the device from easily leaking out to contaminate anything in contact with it.

When silica sand is the liquid absorbing agent the ratio of sand to water is between 200:35 and 35:35 by weight and varies according to the proportion of thickener included.

Furthermore,the time duration of exothermic and endothermic devices is extended by insulating one side of the device with any suitable insulation material to prevent heat loss or gain from the atmosphere. A good material is bubble film, a flexible plastic containing air bubbles. A reflective foil is also useful. Both forms of insulation may be used together or combined.

By making the device as a container, one side of which is insulated, and one side of which can conduct heat, the device will be more efficient in giving heat to or taking heat from the surface to which it is applied.

Alternatively an insulating material can be used separately as a type of bandage to wrap around and insulate the body after the device has been applied.

This method of insulation to prevent heat loss from the exothermic device and heat gain to the endothermic device extends the period of time that the devices remain within the specified temperature ranges.

Furthermore by dividing the container of the device into a plurality of separate compartments each of which contain a heating or cooling composition soluable in water, which composition is separated from the water it reacts with until the two are mixed helps achieve the objects 3, 4 and 5.

In embodiments wherein the container is not to be rigid, it preferably comprises a flexible plastic material. The container is divided into separate compartments each containing exothermic or endothermic material. These compartments are separated from adjoining compartments to prevent the ingredients flowing from one compartment to another. By dividing the outer flexible plastics container into two or more compartments it is also much easier to fold the device along the divisions and thereby mould the device to suit the shape of for example an injured knee joint.

The problems outlined as 3 and 4 above can be overcome by increasing the ratio of thickener to water

between 1:20 to 1:4. Whilst any thickener may be used it has been found that Guar Gum is preferred. If Guar Gum is used, a preferred ratio is between 1:10 and 1:4 by weight for an endothermic device or approximately 1:20 by weight for an exothermic device.

By way of example only the present invention will be illustrated with reference to the following example. The means separating the exothermic or endothermic material from the water is provided by dividing the container into at least two cells, a first cell housing the exothermic or endothermic material and a second cell housing the water. One of the cells can comprise a sachet disposed within the other cell.

The thickener may be admixed with the exothermic or endothermic material and/or the water. Alternatively, the thickener may be present in a separate cell enclosed within the container.

Any suitable structure of the device that separates the exothermic or endothermic material from the water, until the device is activated, e.g. by rupturing a membrane separating the components, and allows the exothermic or endothermic material, water and thickener to come into contact with each other, when the device is activated, may be utilised.

Preferably, the container of the heating or cooling device according to the present invention is not completely filled. More preferably, the container is only approximately 50 percent filled by the components so that the means separating the water and the endothermic or exothermic material can be broken, allowing the two to mix.

The exothermic or endothermic material utilised in the heating or cooling device according to the present invention is preferably a salt. A suitable exothermic material for use in a heating device according to the present invention is calcium chloride.

Preferably this material is provided in crystalline form, and the crystals are graded by size so that a size gradient can be set up. The sizes of such crystals will preferably be from 1 to 5mm in diameter, but will not be limited to such sizes. The ratio of crystals size used will very with the temperature range and duration required. If high initial temperatures and short duration times are required the majority of crystals used will be at the lower end of the scale but as longer durations are required more crystals of larger size will be used. Thus for medical use in contact with the skin a ratio of 1-2mm particles and 2 to 5mm particles of between 20:20 and 5:35 by weight will be preferred.

When calcium chloride is used as the salt, the ratio of water to calcium chloride in the device is preferably approximately 70:55 by weight.

Suitable endothermic materials for use in a cooling device according to the present invention include ammonium nitrate, hydrated sodium sulphate, hydrated disodium hydrogen phosphate, hydrated sodium carbonate, hydrated sodium borate and urea. The particularly preferred endothermic material is ammonium nitrate for pharmaceutical use but for veterinary use and for pharmaceutical use where a colder temperature is desired a particularly preferred endothermic material is a mixture of ammonium nitrate and urea.

When ammonium nitrate is used as the salt, the ratio of water ammonium nitrate in the device is preferably approximately 1:1 by weight.

When a mixture of ammonium nitrate and urea is used, the ratio of ammonium nitrate to urea to water is preferably approximately 195:260:195 by weight.

If desired, the water present in the heating or cooling device may contain a dye. The dye is useful for indicating good mixing of the exothermic or endothermic material with the water, as described hereafter. A cooling device may contain a blue dye and a heating device may contain a red dye.

The thickener used in the heating or cooling device is any suitable material which, when contacted with water, raises the viscosity of the resulting mixture above that of water.

For example, suitable thickeners include gums, algenates, starch products and cellulose products.

Suitable gums include polysaccharides, exudate gums and xanthan gums. Examples of polysaccharides are seed gums, seaweed extracts and guar gum. Of the suitable gums, guar gum and xanthan gums have been found to be preferred especially guar gum when are mixed with water in a ratio of 1:2 by weight.

If a starch product is used as thickener or gelling agent, the product is preferably pre-gelled since this allows it to act satisfactorily as a thickener when added to cold water. Suitable starch products include starch based wallpaper paste and dried mashed potato. Starch based products which are prepared in the form of flakes or in a granular form,for example pellets are preferred since these do not tend to go "lumpy" when added to water. Suitable commercially available starch based wallpaper pastes include Lap and Solvite ("Solvite" is a Trade Mark).

Raw starch may also be used but is less preferred since it is not a pre-gelled starch.

Suitable cellulose thickeners or gelling agents

include cellulose based wallpaper pastes for example Polycell ("Polycell" is a Trade Mek).

A number of suitable thickening or gelling agents have been described above. However, any material which, when added to water, increases the viscosity of the mixture above that of water is suitable for use in the heating or cooling device according to the present invention. For example, any gum which has a thickening action in the presence of a salt may be utilised.

The thickening or gelling agents may be utilised in either the heating or cooling device according to the present invention.

However, the thickening effect of raw starch is more efficient in the case of a heating device according to the present invention than in the case of a cooling device.

Finally, in connection with the thickening or gelling agents, certain gums are affected by ions and these are to be considered less suitable for use in the device according to the present invention.

The amount of thickener used will depend on the amount of endothermic or exothermic material and water used as well as on the particular thickener used. For example, if guar gum is used as thickener, a ratio of thickener to water of 1:2 to 1:15 by weight has been

found to be suitable, although ratios outside this range may be used.

The activation of the device according to the present invention will be discussed in more detail below.

The means separating the exothermic or endothermic material from the water must be of sufficient strength to keep these components apart during transport and storage and until the device is activated but must be capable of being broken readily when the device is to be activated. For example, in one embodiment the water is housed in a second plastics material container enclosed within a first plastics material container, the container housing the water must be of sufficient strength such that it is not broken during transport or storage but must be weak enough to be ruptured when the device is hit, for example by a fist, when the device is to be activated. Further, the first plastics material container must be of sufficient strength such that it is not broken or damaged when the second plastics material container is being ruptured.

In the description of the operation of the heating or cooling device detailed below, specific reference will be made to a heating or cooling device in which the water is housed in a second flexible plastics material

container enclosed within the first flexible plastics material container, the exothermic or endothermic material is housed in the first container and the thickener is admixed with the exothermic or endothermic material. However, a similar operation of the device may be utilised in other embodiments of the present invention.

When the device is to be activated, the second plastics material container housing the water is hit, preferably with a fist, such that the bag is broken and the water is allowed to mix with the exothermic or endothermic material and thickener mixture. The resulting mixture is then "worked" by hand in order to ensure adequate mixing of the ingredients of the heating or cooling composition. The aforementioned dye makes the water visible so that it can be ensured that the mixing is sufficiently thorough to achieve penetration of the water throughout the device. The use of a light coloured sand ensures that the sand does not obscure the colour of the dye. After a short period of time, for example 5 to 10 seconds, the mixture begins to thicken and form a gel and is allowed to settle into the bottom half of the first container.The first container is then folded over such that the heating or cooling composition is contained in one of the folded portions

of the first container and the second folded portion of the first container holds any gases present in the bag. For example, the gases may be air and, in the case of a cooling device utilizing ammonium nitrate as the salt, ammonia. If the portion containing the gases is folded over such that it rests on one surface of the portion housing the heating or cooling mixture, it can act as an insulator by reducing heat transfer between the heating or cooling mixture and the surrounding environment. The remaining exposed surface of the portion containing the heating or cooling mixture may then be contacted with the object to be heated or cooled. For example, in the case of medical use, the remaining surface or a part thereof of the folded portion containing the heating or cooling composition may be contacted with the skin.

Although the operation of the heating or cooling device described above refers to the folding of the first container, it may be used in the unfolded state when this is desired.

Thus, where for example the device comprises a plurality of water containing and exothermic or endothermic mixture containing compartments each separated from each other there is no need to fold the device since the heating or cooling composition is distributed throughout the device, as opposed to the case above where it moves to the bottom.

The use of a thickener in the heating or cooling device according to the present invention has three important advantages. Firstly, when added to the water present in the device, it increases the viscosity of the resulting mixture above that of water and thereby slows down the dissolution of the exothermic or endothermic material in the water. This results in the device according to the present invention producing an increase or lowering in temperature. This is particularly important in medical uses, as described above, wherein very high or low temperatures are undesired. Secondly, the slowing down of the dissolution of the exothermic or endothermic material results in the device reamining at an elevated or lowered temperature for a longer period of time. This prolonged life is achieved by the fact that the exothermic or endothermic material dissolves much more slowly than in previously known devices and the fact that the increase in viscosity reduces heat circulation within the cooling composition, i.e. heat transfer by convection is substantially reduced and the main heat transfer is by the much slower process of conduction. Thirdly, the increase in viscosity achieved by the use of a thickening or gelling agent keeps the heating or cooling composition localised in the first container.

Since the thickening or gelling agent should increase the viscosity of the mixture above that of water before a substantial amount of the exothermic or endothermic material has dissolved in the water, the exothermic or endothermic material should be in a crystalline form. If a fine powder is utilised, the effectiveness of the thickening agent is substantially reduced in that a substantial portion of the exothermic or endothermic material may dissolve before the thickening agent has increased the viscosity.

In the device according to the present invention the first container is a laminated material having an inner flexible polyethylene layer and an outer nylon reinforcement. Such a container will withstand the force exerted on initiation, for example by hitting the first container and breaking open the second container or compartment housing the water.

A suitable material for forming the first container is a laminated material having a polyethylene layer, a second paper layer and a third layer of a nylon reinforcement between said polyethylene and paper layers. The exposed polyethylene surface is used as the inner surface of the container and the paper layer is used as the outer layer. The paper layer is preferably present when the device is to be used for human medical purposes since it gives the device a satisfactory "feel"

when placed in contact with the skin. Since the primary purpose of the paper layer is to give the device a satisfactory "feel" it can be omitted if desired, where for example the device will be for veterinary use, where the animal's fur prevents direct contact of the device with the animal's skin.

CLAIMS

1. A heating or cooling device, which comprises a container having enclosed therein a heating or cooling composition comprising a material which is exothermically or endothermically soluble in water, water and a thickener, said heating or cooling device having means separating the exothermic or endothermic material from the water, characterised in that said material which is exothermically or endothermically soluble in water comprises particles of various size.

2. A device as claimed in claim 1, in which the particles of various size include particles of a size sufficient to reduce the overall initial exothermic or endothermic reaction, thereby slowing the reaction down and increasing the length of the reaction time.

3. A device as claimed in claim 1 or 2, in which the material which is exothermically or endothermically soluble in water is a salt.

4. A device as claimed in claim 3, in which the salt is in crystalline form.

5. A device as claimed in any of the preceding claims, wherein the material which is exothermically soluble in water is calcium chloride.

6. A device as claimed in claim 5, wherein the ratio of water to calcium chloride is approximately 70 to 55 by weight.

7. A device as claimed in any of the preceding claims, in which, in the case of an exothermic material, the particle sizes vary between 1 and 5mm in diameter.

8. A device as claimed in claim 7, in which the particle size is graded such that the ratio of 1 to 2 mm diameter particles to 2 to 5mm diameter particles is between 20:20 and 5:35 by weight.

9. A device as claimed in claim 7, in which the particle size is graded such that the ratio of 1 to 2 mm diameter particle to 2 to 5 mm diameter particles is between 40:0 and 20:20 by weight.

10. A device as claimed in any of claims 1 to 4, wherein the material which is endothermically soluble in water is selected from ammonium nitrate, hydrated sodium sulphate, hydrated disodium hydrogen phosphate, hydrated sodium carbonate, hydrated sodium borate and urea.

11. A device as claimed in claim 10, wherein the material which is endothermically soluble in water is ammonium nitrate.

12. A device as claimed in claim 11, wherein the ratio of water to ammonium nitrate is approximately 1:1 by weight.

13. A device as claimed in claim 10, wherein the material which is endothermically soluble in water is a mixture of ammonium nitrate and urea.

14. A device as claimed in claim 13, wherein the ratio of ammonium nitrate to urea to water is approximately 195:260:195 by weight.

15. A device as claimed in any of claims 10 to 14, in which in the case of an endothermic material the particle sizes vary between 1 and 3 mm in diameter.

16. A device as claimed in any of the preceding claims, in which the device has an insulating layer provided on a surface thereof.

17. A device as claimed in claim 16, in which the insulating layer is medicated.

18. A heating or cooling device which comprises a container having enclosed therein a heating or cooling composition comprising a material which is exothermically or endothermically soluble in water, water and a thickener, the said heating or cooling device having means separating the exothermic or endothermic material from the water, characterised in that said device further comprises a substance or substances which together or alone provide absorption of solution and heat sink properties.

19. A device as claimed in claim 18, in which said substance or substances which together or alone provide absorption of solution and heat sink properties is any suitable solid or liquid with a high specific heat coefficient.

20. A device as claimed in claim 19, wherein said substance or substances which together or alone provide absorption of solution and heat sink properties are selected from silica sand and silver sand.

21. A device as claimed in any of claims 18 to 20, wherein the ratio of the substance or substances which together or alone provide adsorption of solution and heat sink properties and the heating composition is between 300:40 and 40:40 by weight in the case of an exothermic device.

22. A device as claimed in any of claims 18 to 20, wherein the ratio of the substance or substances which together or alone provide adsorption of solution and heat sink properties and the cooling composition is between 50:50 and 50:20 by weight in the case of an endothermic device.

23. A device as claimed in any of the preceding claims, in which the device has another side insulated with an insulating material.

24. A device as claimed in claim 23, wherein the another insulating material is a flexible plastics containing air bubbles and/or a reflective material.

25. A device as claimed in any of the preceding claims, in which the container is divided into a plurality of separate compartments, each of which

contain a heating or cooling composition soluble in water, which composition is separated from the water it reacts with until the two are mixed.

26. A device as claimed in claim 23, wherein each compartment is subdivided into cells, one housing the water and one housing the endothermic or exothermic material.

27. A device as claimed in claim 26, wherein the cell housing the exothermic or endothermic material may be readily ruptured to release the exothermic or endothermic material in the cell housing the water.

28. A device as claimed in claim 27, where the cell to be ruptured is a sachet.

29. A device as claimed in any of the preceding claims, where the thickener is selected from the group comprising gums, algenites, starch products and cellulose products.

30. A device as claimed in claim 29, wherein the ratio of thickener to water is between 1:2 and 1:15 by weight.

31. A device as claimed in claim 29, wherein the gums include polysaccharides such as seedgums, seaweed extracts and guar gum.

32. A device as claimed in claim 31, wherein the ratio of guar gum to water is 1:2 by weight.

33. A device as claimed in any of the preceding claims, in which the container is no more than 50% full with water.

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